Geophysical Research Abstracts
Vol. 19, EGU2017-8713, 2017
EGU General Assembly 2017

Subsidence due to peat compaction and oxidation in built-up deltas

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Deltas are often densely populated, and are predicted to face continued population growth and urbanization. At the same time, deltas are threatened by relative sea-level rise due to the combined effect of land subsidence and global sea-level rise. Many deltaic sequences contain large amounts of peat. In such organo-clastic deltas, peat compaction and oxidation are important contributors to total subsidence. Especially in built-up areas, (differential) subsidence and associated increased flood risk, result in high costs related to damage to buildings and infrastructure. Yet, subsidence due to peat compaction and oxidation in built-up deltaic areas has not been given sufficient attention. These processes have mostly been studied separately, in rural or pristine areas. To develop tailor-made subsidence management strategies for built-up areas in organo-clastic deltas, a thorough understanding of peat compaction and oxidation, and their spatial and temporal variability, is needed.
Therefore, we investigated the relative contribution of both peat compaction and oxidation to subsidence in three built-up areas in the Rhine-Meuse delta, The Netherlands. We used (1) borehole data to construct lithological cross sections of the Holocene sequence, (2) dry bulk density and organic-matter content measurements to assess the degree of compaction, and (3) respiration measurements to determine the oxidation potential. We assessed subsidence due to peat compaction or oxidation of up to ∼2 meters over the last 1000 years, and subsidence rates of up to ∼16 cm·yr-1. The amount and rate of subsidence due to peat compaction and oxidation, and the relative contribution of both processes, is however highly variable in time and space, depending on the Holocene sequence composition, loading conditions, and groundwater-table lowering. For example, subsidence in a sequence with a heavily loaded peat layer will have been mostly caused by peat compaction, while subsidence in a sequence with a thick peat layer with no or a thin clastic overburden, and a relatively deep groundwater table, will have been mostly caused by oxidation. In the built-up areas we investigated, there is still much potential for future subsidence due to peat compaction and oxidation. This is also expected in other organo-clastic deltas. In order to develop subsidence management strategies for such areas, we propose to use subsurface-based spatial planning, in which subsurface lithological information is used to determine the most suitable areas for new built-up areas.